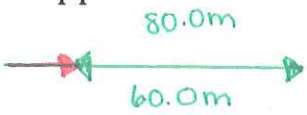
VECTOR APPLICATIONS ANSWER KEY

1. You have two displacement vectors: an 80.0 m vector and a 60.0 m vector. Find the magnitude of the sum of the displacements if the vectors are:
   a. In the same direction.

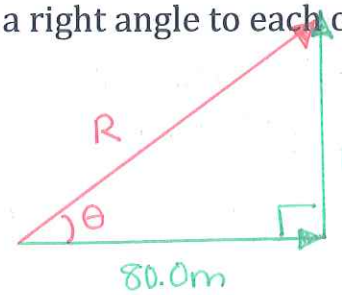
80.0m + 60.0m = **140 m**

   b. In opposite directions.



80.0m − 60.0m = **20.0m**

   c. At a right angle to each other.

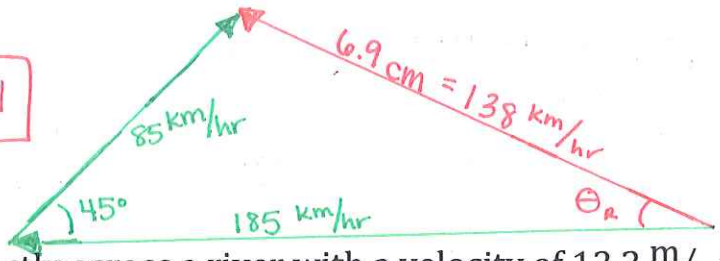


$R = \sqrt{(80.0m)^2 + (60.0m)^2}$

R = 100. m

2. An airplane flies due west at 185 $^{km}/_{hr}$ with respect to the air. There is a wind blowing at 85 $^{km}/_{hr}$ to the northeast relative to the ground. What is the plane's overall velocity with respect to the ground?

1 cm = 20 km/hr



138 km/hr @ 28° N of W

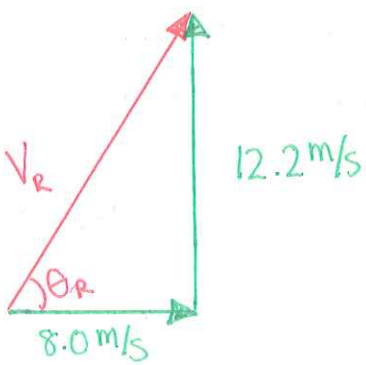
3. A boat heads directly across a river with a velocity of 12.2 $^{m}/_{s}$ to the North, but simultaneously gets swept downstream by the current with a velocity of 8.0 $^{m}/_{s}$. Sketch the appropriate vector diagram to determine the resultant velocity of the boat.

$V_R = \sqrt{(8.0\,m/s)^2 + (12.2\,m/s)^2}$

$V_R = 15\,m/s$

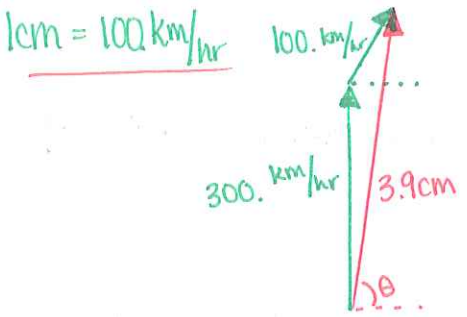
$\theta_R = \tan^{-1}\left(\frac{12.2\,m/s}{8.0\,m/s}\right)$

$\theta_R = 57°$



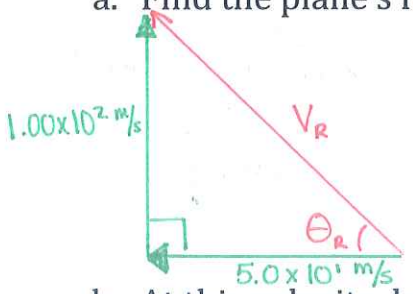
15 m/s @ 57° N of E

4. An airplane flies with a velocity of 300. $^{km}/_{hr}$ due North. A wind blows the plane off track by blowing with a velocity of 100. $^{km}/_{hr}$ 60° N of E. Find the resultant velocity of the plane relative to the ground.



390 km/hr @ 83° N of E

5. A plane flying toward a heading of 90° at 1.00×10^2 $^{m}/_{s}$ is blown toward a heading of 180°at 5.0×10^1 $^{m}/_{s}$ by a strong wind.
   a. Find the plane's resultant velocity and direction.



$V_R = \sqrt{(5.0\times10^1)^2 + (1.00\times10^2)^2} = 112$ m/s

$\theta_R = \tan^{-1}\left(\frac{1.00\times10^2}{5.0\times10^1}\right) = 63°$

112 m/s @ 63° N of W

   b. At this velocity, how far will the plane travel in 2 hours?

$d = V \cdot t$ 2hr = 7200s

$= (112\ m/s)(7200s)$

$d_1 = 806{,}400$ m @ 63° N of W

   c. The wind has blown the pilot off course. If he wanted to get back to the spot where he would have been if there had been no wind, how far and in what direction would he need to fly?

$d_{plane\ w/o\ wind} = V_{plane} \cdot t$

$= (1.00\times10^2\ m/s)(7200s)$

$d_2 = 7.2\times10^5$ m

$d_{1x} = 806{,}400 \cdot \cos 63° = 366{,}098$ m

$d_{1y} = 806{,}400 \cdot \sin 63° = 718{,}508$ m

$d_{2x} = 0$ m

$d_{2y} = 7.2\times10^5$ m

$d_{2y} - d_{1y} = 1492$ m

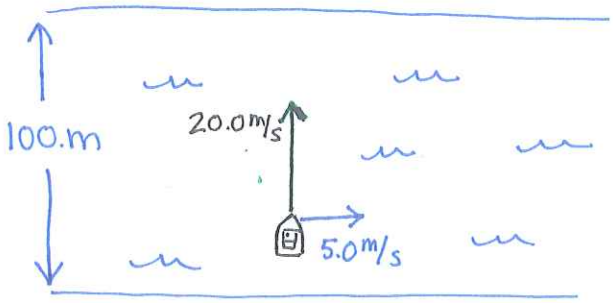
$d_R = \sqrt{366{,}098^2 + 1492^2}$

$d_R = 3.7\times10^5$ m

$\theta_R = \tan^{-1}\left(\frac{1492}{366098}\right)$

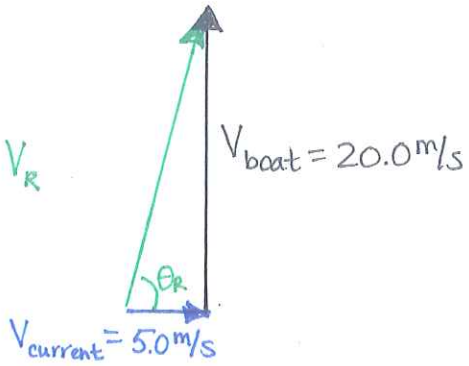
$\theta_R = 0.2°$ N of E

6. Pat jumps in a boat to get across a 100. meter wide river. The river has a current that flows at 5.0 $^{m}/_{s}$. Pat's velocity heading straight across the river to the opposite bank is 20.0 $^{m}/_{s}$.
   a. Make a sketch showing what the situation looks like.



   b. Make a scaled vector sketch of the boat's velocity, the river's current and the resultant velocity of the boat.

1 cm = 5.0 m/s



   c. How far downstream will the boat be when it gets to the other side?

$d_{\text{down stream}} = V_{current} \cdot t$

$= (5.0\ m/s)(5.00\ s)$

$t = \frac{d_{river}}{V_{boat}} = \frac{100.\ m}{20.0\ m/s}$

$t = 5.00\ s$

$d = 25.0\ m$